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SUPERSEDING
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DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

MULTIFUNCTION AMPLIFIER ASSEMBLY

1. SCOPE

1.1 Scope.- This specification sets forth the requirements for a multifunction amplifier assembly which consists of (1) a multifunction amplifier cabinet, including a patch and test panel, designed for standard rack mounting; (2) plug-in amplifier base modules; and (3) submodules that provide additional functional capabilities. The equipment will be used in FAA facilities to perform the required processing of audio used in the air-to-ground voice communication systems. The power supply is dual solid-state and modular in construction. The amplifier assembly is solid-state and modular in construction.

1.2 Definitions and acronyms.-

1.2.1 Definitions.-

AC line power	The term "ac line power", as used herein, shall denote a power derived from a three-wire ac line and with a design center voltage of 120 V as required by FAA-G-2100/1.
Amplifier power supply voltage	The term "amplifier power supply voltage", as used herein, shall denote 24 V dc as furnished by the power supply (3.3.6).
Base module	The term "base module", as used herein, shall denote a plug-in module which plugs directly into

	one of the 12 positions on the assembly chassis.
Cross talk	The term "cross talk", as used herein, shall denote power between amplifiers measured according to test procedures defined herein.
Hum distortion frequency	The term "hum distortion frequency", as used herein, shall denote any frequency appearing in the output circuit and resulting from the combination of the signal frequency and ripple components of the dc power source.
Input signal level	The term "input signal level", as used herein, shall denote any level of signal delivered to the input terminals of the base amplifier when the base amplifier is combined with a submodule amplifier.
Input stage	The term "input stage", as used herein, denotes the single input or quadruple input to the amplifier module.
Linear amplifier submodule	The term "linear amplifier submodule", as used herein, shall denote a submodule whose function is to produce linear amplification of audio frequency signals.
Mixer amplifier submodule	The term "mixer submodule", as used herein, shall denote a submodule which converts the basic module to a mixer amplifier.
Mixing stage	The term "mixing stage", as used herein, shall denote the stage or component of the mixer submodule wherein mixing of the signals from the four input channels occurs.
Output signal level	The term "output signal level", as used herein, shall denote the level of signal delivered from the output terminals of the basic amplifier when it is combined with an amplifier submodule.
Regulated amplifier output submodule	The term "regulated output submodule", as used herein, shall denote a submodule whose function is to provide 30 dB of regulation at the rated output level.
Sensitivity	The term "sensitivity", as used herein, shall denote the magnitude of input signal required to produce an output of plus 33 dBm for an amplifier with maximum gain as required herein.

Service conditions	The term "service conditions", as used herein, shall denote environment I as specified by FAA-G-2100-1.
Submodule	The term "submodule", as used herein, shall denote a unit which plugs into the base module.
Test signal	The term "test signal", as used herein, shall denote a signal applied to the amplifier input from a signal generator whose internal impedance is 600 ohms.
Tone suppression amplifier sub-module	The term "tone suppression submodule", as used herein, shall denote a submodule whose function is to provide suppression of a sinusoidal tone when it is injected into the voice channel.

1.2.2 Acronyms.-

AGC	Automatic gain control
ARTCC	Air route traffic control center
FAA	Federal Aviation Administration
FSS	Flight Service Station
MTBF	Mean-time-between-failures (a reliability term)
MTTR	Mean-time-to-repair (a maintainability term)
RCAG	Remote-controlled, air-to-ground radio communication facility

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The following FAA specifications and standards, of the issues specified in the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

2.1.1 FAA specifications.-

FAA-G-2100/1	Electronic Equipment, General Requirements Part 1, Basic Requirements for All Equipments
FAA-G-2100/3	Electronic Equipment, General Requirements Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Electronic Equipment, General Requirements Part 4, Requirements for Equipments Employing Printed Wiring Techniques

FAA-D-2494/1	Technical Instruction Book Manuscripts: Electronic Equipment, Requirements for; Part I - Preparation of Manuscript
FAA-D-2494/2	Technical Instruction Book Manuscripts: Electronic, Electrical, and Mechanical Equipment, Requirements for: Part II - Preparation of Reproducible (Camera-Ready) Copy and Original Artwork

2.1.2 FAA standard.-

FAA-STD-016	Quality Control System Requirements

2.1.3 FAA Drawing.-

D-21342H	Standard Door Panel and Vertical Chassis Assembly

2.2 Military specification.-

MIL-E-17555	Electronic and Electrical Equipment, Accessories, and Repair Parts; Packaging and Packing of

(Copies of this specification and other applicable FAA specifications, standards, and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.)

(Single copies of applicable federal and military specifications, standards, and drawings may be obtained by ordering through the Naval Publications and forms Center (NPFC), Philadelphia, which is the Department of Defense Single Stock Print (DOD-SSP) and distribution center for unclassified specifications and standards. Documents may be ordered by writing: Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120; or calling: Area Code: 215-697-3321, Monday through Friday, from 8 a.m. to 4:30 p.m., Philadelphia time.)

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each multifunction amplifier assembly furnished by the contractor shall be in accordance with requirements stated herein and shall include the items tabulated below. Instruction books shall be furnished in accordance with FAA-D-2494/1 and FAA-D-2494/2 and in quantities specified in the contract schedule.

(a) Multifunction amplifier cabinet (3.2, 3.4.1)

(b) Base amplifier module (3.3.1)

(c) Linear amplifier submodule (3.3.2)

(d) Regulated output amplifier submodule (3.3.3)

(e) Mixer amplifier submodule (3.3.4)

(f) Tone suppression amplifier submodule (3.3.5)

(g) Power supply requirements (3.3.6)

(h) Module test adapter (3.3.7)

(i) Test set (3.3.8)

(j) Patch and test panel (3.4.1.8)

(k) Instruction books (3.9)

Insofar as the contract schedule requires one or more prototype equipments, these shall meet all requirements of 3.8 and subparagraphs thereunder.

3.2 Multifunction amplifier description.- The multifunction amplifier cabinet shall be able to contain 12 plug-in base amplifier modules, each modified by submodule plug-in devices. The individual base amplifier modules with submodules attached shall be of four types: linear amplifier, regulated output amplifier, mixer amplifier, and tone suppression amplifier. The linear amplifier module shall provide linear amplification of complex signals. The regulated output amplifier shall provide 30 dB of regulation. The mixer amplifier module shall combine four input signals into a single output signal. The tone suppression amplifier module shall provide at least a 10-dB reduction in gain below a predetermined regulated voice output when a sinusoidal tone is introduced into the audio channel. The individual amplifier module shall employ solid-state electronic components and printed circuits. The four submodules shall be mechanically interchangeable in the base module, and shall be able to derive dc electric power from the base module. The test set shall supply power and test signals for individual modules and submodules. The module test adapter shall be a plug-in extender board. The module test adapter shall accept plug-in connection with any amplifier module, thereby permitting electrical testing, servicing, and repair of the amplifier module. The power supply shall supply dc power to the amplifier modules.

3.3 Performance requirements.-

3.3.1 Base amplifier module.- Each base amplifier module (or base module) shall plug into the amplifier cabinet. Each base module shall mate with any submodule plug-in unit.

3.3.1.1 Performance of base module with submodule.- Each module in combination with a submodule shall perform an amplifier function in accordance with 3.3.1.2 to 3.3.1.11.

3.3.1.2 Maximum gain.- The maximum gain shall be not less than 85 dB at 1000 Hz.

3.3.1.3 Rated output.- A 1000-Hz input signal of minus 52 dBm shall produce an output level of not less than plus 33 dBm for the maximum gain setting of the gain control. The input signal shall be supplied from a source having a balanced 600-ohm output impedance.

3.3.1.4 Frequency response.- The frequency response at plus 33 dBm output shall not vary more than a total of 2 dB between 300 Hz and 2500 Hz. The response shall drop off continuously for frequency decreasing below 300 Hz and for frequency increasing above 2500 Hz. The response at 100 Hz and 10 kHz shall be at least 6 dB below the response at 1000 Hz.

3.3.1.5 Harmonic distortion.- When a signal in the range of 300 Hz to 2500 Hz is applied to the input with the gain control set to give an output level of plus 33 dBm, the total harmonic distortion shall not be greater than 5 percent.

3.3.1.6 Hum distortion.- When a signal in the range of 300 Hz to 2500 Hz is applied to the input with the gain control set to give an output level of plus 33 dBm, the total level of all output hum distortion frequencies shall not exceed minus 40 dBm.

3.3.1.7 Noise level.- Noise level, including hum at the output with no input signal, shall not be greater than minus 50 dBm with the gain controls set for 25 dB gain and minus 15 dBm output. This requirement shall be met with the amplifier input shorted and the output properly terminated.

3.3.1.8 Cross talk.- When the cabinet assembly contains a full complement of 12 amplifier modules with submodules attached, and each amplifier is properly terminated, the cross talk signal measurement shall not exceed the requirements of the following subparagraphs.

(a) When each amplifier module and submodule is set to provide at least 85 dB gain, and a test signal in the range of 300 Hz to 2500 Hz is applied to the input of one module so as to provide an output of plus 33 dBm on that module, no component of the test signal shall appear on the output of any other module which exceeds minus 40 dBm.

(b) When a distinctive test signal at minus 25 dBm in the range of 300 Hz to 2500 Hz is applied to input of each module and the gain is adjusted to provide plus 33 dBm on the output, no cross talk component from any other amplifier shall exceed minus 50 dBm.

3.3.1.9 No load operation.- With no input attenuation and a signal of minus 8 dBm at 1000 Hz applied to the input for a period of not less than 2 hours, and with no load connected to the output, no component part shall be subjected to conditions beyond its rated values.

3.3.1.10 Gain control.- The gain shall be controlled by a potentiometer equipped with a screwdriver adjustment capable of not less than 300 degrees rotation. The gain control shall be easily adjustable from the front of the amplifier cabinet in the normal operating configuration.

3.3.1.11 Output transformer.- An output transformer shall isolate the transistor circuitry from the external equipment. The output transformer secondary shall consist of two equal windings so arranged that, when connected, series-adding specification requirements will be met when the load impedance is 600 ohms noninductive. Either winding shall provide the design value of primary impedance within plus or minus 10 percent when bridged by a noninductive load of 150 ohms. Output ground resistance measured from each transformer output terminal to ground shall be greater than 1 megohm.

3.3.2 Linear amplifier submodule.- The linear amplifier submodule shall be a plug-in submodule which enables the base module to perform a linear amplification function.

3.3.2.1 Linear amplifier function.- The linear amplifier module, composed of a base module and linear amplifier submodule, shall be in accordance with 3.3.1.2 through 3.3.1.11 and also 3.3.2.2 through 3.3.2.5.

3.3.2.2 Input circuits.- Each amplifier shall have ungrounded (balanced) inputs which meet the requirements stated in the following subparagraphs.

3.3.2.2.1 Input transformer.- Each amplifier shall be designed and furnished with input circuitry including a hum-shielded transformer with a 600-ohm (design-center value) primary winding.

3.3.2.3 Input ground.- Resistance measured from each transformer input terminal to ground shall be greater than 1 megohm.

3.3.2.4 Input impedance tolerance.- The input circuit of each channel at all attenuator settings shall reflect an impedance to the line within plus or minus 20 percent of the rated design-center impedance; this requirement shall be met over the frequency range 300 to 2500 Hz.

3.3.2.5 Input shielding.- The input transformer shall have multiple shields for protection against pickup of external magnetic fields. Hum pickup suppression shall be not less than 90 dB compared to the unshielded transformer.

3.3.3 Regulated output amplifier submodule.- The regulated output amplifier submodule shall be a plug-in submodule which enables the base module to perform a regulated output amplifier function.

3.3.3.1 Regulated output amplifier function.- The regulated output submodule, when attached to the base amplifier module, shall provide the AGC circuitry required to function as a regulated output controlled amplifier. In addition to the performance requirements of 3.3.1.2 through 3.3.1.11 and 3.3.2.1 through 3.3.2.5, the regulated output amplifier function shall meet the following requirements.

3.3.3.2 Gain.- The maximum unregulated gain shall be in accordance with 3.3.1.2.

3.3.3.2.1 Sensitivity.- A 1000-Hz input signal of minus 60 dBm shall produce an output level of not less than plus 23 dBm with regulation when the input and output attenuators are set at minimum loss.

3.3.3.3 Regulator output control range.- With an input signal of minus 60 dBm and the input attenuator set for zero attenuation, the gain control of the base amplifier shall permit adjustment of the regulated output of the amplifier to any values within the range of minus 8 dBm to plus 23 dBm.

3.3.3.3.1 Input attenuator.- An input attenuator shall be provided with an attenuation range from 0 dB to 60 dB. The attenuator shall be continuously variable. The input impedance requirement defined herein shall be satisfied at all settings of the attenuator control.

3.3.3.4 Regulator input control range.- The input control range shall be minus 60 dBm to minus 30 dBm.

3.3.3.5 Regulating range.- With an input signal of 1000 Hz at minus 60 dBm, the input attenuator set for zero attenuation, and the regulator output control set to provide an output signal level in the range of plus 23 dBm to minus 8 dBm, a slow increase (occurring in approximately 2 seconds) in input signal to minus 30 dBm shall not cause the output signal to increase by more than 3 dB.

3.3.3.6 Regulator attack time.- Under the conditions of 3.3.3.3, a sudden increase in the input signal level from minus 60 dBm to minus 30 dBm shall not cause the instantaneous output level, including transients, to increase by more than 5 dB or decrease by more than 3 dB. The output level shall be within plus 3 dB of the final steady state value and shall stabilize within 10 milliseconds from the instant of input level change.

3.3.3.7 Regulator release time.- Immediately following the 10-millisecond stabilizaton period of 3.3.3.6 with a sudden decrease in the input signal level from minus 30 to minus 60 dBm, the output level shall stabilize to within 3 dB of the final steady state value in not less than 400 milliseconds nor more than 600 milliseconds from the instant of input level change.

3.3.4 Mixer amplifier submodule.- The mixer amplifier submodule shall be a plug-in device which enables the base module to perform a mixer amplifier function.

3.3.4.1 Mixer amplifier function.- The mixer amplifier function shall be available from the combination of the base module and mixer amplifier submodule. The mixer amplifier function shall be to combine four input signals into a resultant single, low-level signal and to amplify that single low-level signal. The mixer amplifier function shall be in accordance with 3.3.1.2 through 3.3.1.11.

3.3.4.2 Four input circuits.- The mixer submodule shall have four input circuits, each electrically equivalent to the input circuit defined in 3.3.2.1 through 3.3.2.5. These input circuits shall include provisions for four attenuator pads and four level adjusters.

3.3.4.3 Attenuator mounting terminals.- The mixer submodule shall provide terminals for insertion of four fixed attenuator devices, one in each of the four signal channels in the submodule leading to the input transformers. Terminals shall be provided for connecting the H-pad attenuators.

3.3.4.4 Input signal levels.- The nominal input signal levels shall be minus 40 dBm to plus 10 dBm.

3.3.4.4.1 Output level adjustment.- For the mixer amplifier module, there shall be an output level adjustment for each channel, adjustable on the submodule without the use of extenders, test fixtures, etc.

3.3.4.5 Input attenuator pads.- The fixed input attenuator pads shall be of resistive-type, balanced H configuration having an input and output impedance of 600 plus or minus 30 ohms. Formula and method for calculating pad components shall be included in the instruction books for all integer values from 30 to 60 dB. A nomograph may be used to provide these data if desired.

3.3.5 Tone suppression amplifier submodule.- The tone suppression amplifier submodule shall be a plug-in device to be attached to the base amplifier module. This combination shall provide the tone suppression amplifier function.

3.3.5.1 Tone suppression amplifier function.- The tone suppression amplifier submodule shall provide the performance requirements of 3.3.1.2 through 3.3.1.11, 3.3.2.2 through 3.3.2.5, and the following subparagraphs.

(a) Reduce the overall gain of the amplifier if any sinusoidal tones are introduced into the speech channel.

(b) Limit the maximum output audio level by automatically reducing amplifier gain when the audio level reaches a predetermined value.

(c) Provide noise suppression when the input level is below a predetermined value by reducing the gain of the amplifier.

3.3.5.2 Regulator output control range.- With an input signal of minus 40 dBm and the input attenuator set for zero attenuation, the gain control of the amplifier shall permit adjustment of the regulated output to any value within the range of minus 8 dBm to plus 12 dBm.

3.3.5.3 Regulator input control range.- The input control range shall be from minus 40 dBm to plus 20 dBm.

3.3.5.4 Regulating range.- With an input signal of minus 40 dBm and the output signal set within the range of minus 8 dBm to plus 12 dBm, a slow increase in the input signal to minus 20 dBm shall not cause the output signal to increase by more than 2 dB.

3.3.5.5 Regulator attack time.- A sudden increase in the input signal level from minus 40 dBm to minus 10 dBm shall allow the output signal to stabilize within 10 milliseconds from the instant of input level change.

3.3.5.6 Regulator release time.- Immediately following the 10-millisecond stabilization period, a sudden decrease in the input signal level from minus 10 dBm to minus 40 dBm shall allow the output level to stabilize in not less than 400 milliseconds and not more than 600 millisecond from the instant of the input level change.

3.3.5.7 Tone suppression.- When a sinusoidal tone is introduced into the audio channel, the gain of the amplifier shall be reduced by at least 10 dB below the regulated voice output level.

3.3.5.8 Noise suppression.- Noise suppression shall be provided such that any signal below an adjustable predetermined threshold (minus 50 dBm to minus 40 dBm) shall be amplified no more than 6 dB.

3.3.5.9 Output level.- A voice signal at an input level of minus 52 dBm shall produce an output level of not less than plus 33 dBm when the controls are set for maximum gain.

3.3.5.10 Mode switch.- A mode switch, accessible on the front panel, shall be provided that will disable the tone suppression and noise suppression circuits in order to permit a sine wave generator to be used to make the necessary level and gain adjustments to the amplifier.

3.3.6 Power supply requirements.- The following optional power supplies shall be provided in accordance with the requirements specified herein and in the contract:

(a) Regulated 24 V dc 60 Amp, modular

(b) Regulated 24 V dc 30 Amp, modular

(c) Unregulated 28 V dc, modular

The power supplies shall be capable of supplying power redundantly or individually. Terminations shall be made in barrier terminal strips mounted on the rear of the module. When connected for redundant operation, each power supply module shall be capable of carrying the full load and shall normally carry 50 percent of the load. The 60-ampere and 30-ampere, regulated power supplies shall meet the requirements of 3.3.6.1 and its subparagraphs; the unregulated modular power supply shall meet the requirements of 3.3.6.2 and its subparagraphs.

3.3.6.1 Regulated power supply requirements.-

3.3.6.1.1 Voltage output and ripple.- The voltage output shall be 24 V dc. The ripple shall be less than 1 millivolt rms.

3.3.6.1.2 Regulation.- Regulation of the power supply modules operating in parallel shall not exceed the following limits when tested with amplifier modules connected or individually operated.

3.3.6.1.3 Load regulation.- With an input line variation from 105 to 130 V ac, the dc output shall vary not more than 0.05 percent; when the load changes from 1 ampere to full load, the regulation shall not vary more than 0.2 percent. The ripple shall not exceed 1 millivolt rms with various input line voltage and changing load conditions; the temperature coefficient shall not exceed 0.01° C.

3.3.6.1.4 Regulation response.- The regulation response shall be 100 microseconds or less to within 60 millivolts of nominal value from no load to full load, and shall be 10 milliseconds or less to within 60 millivolts of nominal value from full load to no load.

3.3.6.1.5 Voltage adjustment.- The output voltage shall have a maximum of 1-volt adjustment with 1 millivolt resolution.

3.3.6.1.6 Overload protection.- The output of each power supply module shall be protected by a solid-state, current limiting, adjustable overload control. Upon removal of an overload, the voltage and current shall return to preset levels.

3.3.6.1.7 Overvoltage protection.- Each power supply module shall have an adjustable overvoltage crowbar protection device (spike suppressor).

3.3.6.1.7.1 Module failure.- Upon failure of any individual module or modules for any cause, the failed module will be removed from the load automatically. A failed module will not cause an interruption of the dc output current or voltages of the system.

3.3.6.1.8 AC input.- The equipment shall meet all the following requirements when operated on inputs from 105 to 130 V ac, 50/60 Hz single phase. The requirement, as defined, supersedes FAA-G-2100/1.

3.3.6.1.9 DC output.- The dc output shall be in accordance with 3.3.6.1.1 and shall be adjustable in accordance with 3.3.6.1.5.

3.3.6.1.10 Failure detector.- A built-in failure detector circuit shall be provided in each module to monitor the output voltage. A module failure shall close a circuit terminated on the module terminal strip. Closure of the circuit of the detector will activate an external alarm device (not a part of this specification) such as a light or buzzer. The alarm condition shall be active where output is outside the range of 24 V dc plus or minus 2. The contacts shall be capable of carrying at least 250 milliamperes.

3.3.6.1.11 AC line controls.- The ac line controls shall be mounted on the rear of the power supply module (FAA-G-2100/1). The indicator light is not required. Indicating type ac fuse is required. AC line cord shall be provided in accordance with FAA-G-2100/1.

3.3.6.2 Unregulated power supply requirements.-

3.3.6.2.1 Power supply, modular.- A 28-V dc, unregulated power supply module shall be provided by the contractor. Each modular power supply shall be capable of supplying operating power for up to 24 base amplifier modules with submodules attached. The modular power supply shall normally be used in conjunction with another companion power supply operating in parallel mode. In this configuration the power supplies shall share the operating power load. The modular power supply shall be removable for service and repair.

3.3.6.2.2 Overload protection.- The output of each modular power supply shall be protected by solid-state, current-limiting, overload circuitry in order to prevent internal damage in the event the load current requirement exceeds the capacity of the modular power supply. Upon removal of an overload, the voltage and current will automatically restore to nominal range. In the event of failure of one power supply, a paralleled modular power supply will not be affected other than as required to assume the load previously carried by the failed unit.

3.3.6.2.3 Failure detector.- A built-in failure detector circuit shall be provided to the modular power supply to monitor loss or severe degradation of the output voltage level beyond the nominal range defined below. Upon detection of an out-of-tolerance condition, the failure detector shall enable circuitry which can be used to activate an external alarm-indicating device. Access to this enabling circuitry shall be readily available for attachment to other government-owned devices not defined in this specification. In all cases, the enabling circuit shall be capable of carrying at least 250 milliamperes.

3.3.6.2.4 Voltage output.- The output voltage of the modular power supply shall be 28 V dc nominally. Tolerance of this output voltage shall not exceed plus 9 volts or minus 1 volt.

3.3.6.2.5 Load and line regulation.- The modular power supply shall be regulated such that when the line voltage varies over the range of 105 to 130 V ac the output voltage shall not exceed the levels defined in 3.3.6.2.3 when supplying power to two fully complemented cabinet assemblies each containing 12 base amplifiers with submodules attached.

3.3.6.2.6 Ripple.- The output of the modular power supply shall contain no more than 0.7-V rms ripple under no-load conditions.

3.3.6.2.7 AC line control.- The modular power supply shall be provided with separate ac input provisions. The ac input shall be controlled by a front-mounted OFF/ON switch. The modular power supply shall have a front-mounted ON indicator. The modular power supply shall have a front-mounted fuse holder with visible failure indicator.

3.3.7 Module test adapter.- The adapter shall be designed to permit all types of modules to be extended from the equipment for in-service testing The construction of the adapter shall permit exposure of the electronics for servicing when the adapter is plugged into the assembly and the module is plugged into the adapter.

3.3.8 Test set.- A test set shall be furnished to duplicate the supports, guides, connectors, interwiring, input, and output of all types of modules used in the equipment. The test set shall be designed to permit clear access to all connections for bench operation of all types of modules. Input-output terminal strips shall also be provided to extend the signal and dc voltages. The test set shall permit maintenance personnel to expose all sides of any module or submodule for service, testing, or repair. The test set shall be designed with a self-contained power supply; an audio oscillator with test frequencies of 300, 1000, and 2500 Hz; a meter to measure all the proper levels of operations, including the power supply output voltage; and an output audio speaker with ON/OFF switch. The test set shall include at least one each base amplifier module, regulated output module, linear submodule, mixer submodule, and tone suppression submodule. The test set shall activate the base module, linear submodule, regulated output submodule, mixer submodule, and tone suppression submodule to enable determination of compliance with requirements stated herein.

3.3.9 Interference.- The equipment shall be designed to function in an air route traffic control center (ARTCC), remote-controlled, air-to-ground radio communication facility (RCAG), air traffic control tower (ATCT), and flight service station (FSS) environment. It shall not interfere with, nor be susceptible to, any environmental disturbance which causes or can cause undesired response, malfunction, or degradation of performance. The equipment shall be properly shielded and have the necessary filtering to prevent interference caused by coupling and conduction.

3.4 Construction.- Construction of the various items shall be in accordance with the following subparagraphs.

3.4.1 Amplifier cabinet.- Construction shall be based on a standard relay rack mounting with a size E panel in accordance with figure 1 and FAA Drawing D-21342H. Each of the 12 amplifier modules, conforming with figure 2, shall be readily removable from the rack panel via a plug-in type arrangement. Assembly shall follow method I of Drawing D-21342H, with the modules replacing the hinged door. The chassis shall permit suitable cooling without special cooling devices when similar equipment is stacked closely in relay racks.

3.4.1.1 Chassis material and forming.- Chassis material shall be as noted in Drawing D-21342H, except the front panel material shall be 1/8-inch thick and the supporting chassis material shall be 1/16-inch thick. Forming of the supporting chassis flange, as shown in the A-A detailed section of Drawing D-21342H, shall be such that the chassis flange is bent outward under the mounting support and adds strength to the mechanical assembly.

3.4.1.2 Cabinet guides.- Insulated cabinet guide strips and/or rails shall be provided for a positive alignment of the plug-in modules. The vertical and lateral movement of a plug-in module shall be restricted to less than 1/32 inch when the unit is inserted more than three-fourths of the distance into the assembly. Plug-in modules shall be removable with no more than a 3-pound pull on the handle.

3.4.1.3 Weight.-The total installed weight of the finished assembly shall be not more than 50 pounds.

3.4.1.4 Six (6) position audio connector panel.- This panel shall be constructed such that it can be screw connected to the rear of the multifunction audio amplifier cabinet. These panels shall have six connectors mounted on them into which the base amplifier module can be plugged. When the audio connector panel is mounted on the multifunction audio amplifier cabinet, it shall provide a connection path for the base amplifier module.

3.4.1.5 Power connector panel for 28 V dc modular power supply.- This panel shall be constructed such that it can be screw connected to the rear of the multifunction audio amplifier cabinet. This panel shall have two connectors mounted on them into which the modular power supply can be plugged. The power connector panels shall have dual receptacles for ac power inputs. The contractor shall provide mating connectors for each receptacle. When the power connector panel is affixed to the multifunction audio amplifier cabinet, it shall provide an ac power path connection to the modular power supply. The power connector panel shall provide access to the failure detector defined in 3.3.6.2.3 of the equipment specification.

3.4.1.6 Mating connectors.- Mating cable connectors for the rear cabinet connectors shall be furnished. These shall be of the positive retention design. Mating cable connectors shall include cable strain relief.

3.4.1.7 Module connectors.- Cabinet-mounted module connectors shall be AMP part number 67040-5 or equal to mate with the base amplifier printed circuit boards.

3.4.1.8 Patch and test panel.- The patch panel shall be an integral part of the cabinet assembly, see figure 1. The fixed patchboard shall be mounted on the front panel. The overall depth, measured from the rear of the front panel, shall not exceed 12 inches. The panel shall provide jacks for the input and output feed elements with the following capabilities:

(a) Monitor jacks which bridge circuits without breaking connections.

(b) Line jacks which lift circuits from amplifiers and connect to the external line.

(c) Equipment jacks which lift the circuit going to the external connector and connect to the amplifier input or amplifier output.

3.4.1.9 Nameplate.- A nameplate shall be provided on each unit in accordance with FAA-G-2100/1.

3.4.1.10 Welding.- The chassis shall be formed and continuously butt or fillet welded. All connecting edges shall be cleaned of foreign material and shall be dimensioned for proper fit-up. All welds shall have full penetration and shall be smoothed (on the exterior of the chassis) by

means of a belt sander or equal, maintaining the weld throat dimension not less than the thickness of the connecting metal. Chassis fabrication by riveting, screw fasteners, or spot welding shall not be permitted.

3.4.2 Base module.- Each module shall consist of a printed wiring board with card edge connections to mate with the cabinet-mounted connector specified in 3.4.1.7.

3.4.2.1 Module panel.- Each front panel shall carry the gain control, fuse indicator monitor and test jacks, handle, and designation strip.

3.4.2.2 Printed wiring.- The printed wiring board shall provide for plug-in of any of the submodules.

3.4.3 Submodules.- The submodules shall be constructed on printed wiring boards and shall provide for plug-in into the base module. The submodule shall provide the front panel access to all controls in accordance with figures 1 and 2.

3.4.4 Module test adapter.- The construction of the module test adapter shall be in accordance with 3.3.6.

3.4.5 Power supplies.- The power supplies shall be of modular construction in metal cases. Two modular power supplies shall be mounted in one assembly. The assembly, containing the two power supply modules, shall be capable of being mounted in a standard 19-inch equipment rack. The mounting assembly shall not exceed a size G rack panel space and shall not be more than 14 inches in depth. The two power supplies shall operate in parallel or independently. Terminations shall be made in barrier terminal strips mounted on the rear of the module. The terminations shall be provided with insulating covers. Either power supply module shall be capable of being physically removed from the mounting assembly without disturbing the operation of the remaining power supply module. The contractor shall furnish two handles which shall be mounted in a vertical position, one on each side of the front panel of the power supply panel assembly.

3.4.6 Power distribution panel for regulated 24 V dc modular power supply.- These panels shall be constructed such that they can be screw connected to a standard 19 inch width rack. This panel shall provide the interface to distribute dc power (including redundant dc power) from the regulated 24 V dc modular power supplies to all the base amplifiers (up to 96 amplifiers within one rack). One distribution panel is required for each rack of equipment. The capability to interface dc power (indcluding redundant dc power) from one distribution panel of one rack of equipment to a distribution panel in another rack of equipment shall be provided. The contractor shall provide mating connectors for each receptacle. The power distribution panel shall provide access to the failure detector defined in 3.3.6.1.10.

3.4.7 Test set.- A test set shall be constructed to duplicate the supports, guides, connectors, interwiring, and one amplifier module. It shall permit clear access to all connections for bench operation of the amplifier mod-

ules. A 6-foot, 120-V ac cord and plug shall be attached at the rear of the assembly (FAA-G-2100/1).

3.5 Reliability and maintainability.-

3.5.1 General.- The multifunction amplifier equipments specified herein shall comply with the reliability and maintainability requirements as required by FAA-G-2100/1.

3.5.2 Reliability and maintainability figures of merit.- The equipment specified herein shall be designed to meet the following requirements under service conditions, as specified. Temperature data used for predictions shall be verified in accordance with 4.3 herein.

(a) The predicted MTBF of the submodule and the base module assembled shall be at least 50,000 hours.

(b) The predicted MTTR of the assembled submodule and base module shall be no greater than 5 minutes.

3.5.3 Program plan.- The contractor shall submit a reliability and maintainability program plan within 45 days after award of contract.

(a) The contractor shall prepare a reliability and maintainability prediction report and submit this report within 60 days after contract award. The report shall contain failure rate data on each circuit card used. This report shall be revised periodically and the final report shall be no later than 30 days before demonstration test.

(b) Reliability and maintainability design reviews shall be conducted as required.

3.5.4 Reliability/maintainability demonstration.- Equipment shall be demonstrated in accordance with FAA-G-2100/1. After burn-in, equipment shall accumulate aggregate hours sufficient to demonstrate that the equipment meets the required MTBF and MTTR.

3.5.5 Maintainability considerations.- Module test adapters and test sets shall be provided to facilitate maintenance. Corrective maintenance and preventive maintenance shall be considered on the following basis:

(a) In the event of a failure, it shall be possible to restore the equipment to an operational condition within 5 minutes. This fault correction time is based on removing and replacing with a like module or circuit card.

(b) Preventive maintenance shall be minimized. Preventive maintenance of devices that do not present wear-out problems shall be required. A minimal level of preventive maintenance, not to exceed 0.5 hour per month per equipment rack, for purposes of changing filters, oiling blowers, etc., is permissable.

3.6 General requirements.-

3.6.1 Materials and components.- All materials and components used in the multifunction amplifier assembly shall be in accordance with FAA-G-2100/1.

3.6.2 Semiconductor devices.- Semiconductor devices used in the multifunction amplifier assembly shall be in accordance with FAA-G-2100/3.

3.6.3 Printed wiring.- Devices with printed wiring used in the multifunction amplifier assembly shall be in accordance with FAA-G-2100/4.

3.6.4 Microelectronic devices.- Microelectronic devices used in the multifunction amplifier assembly shall be in accordance with FAA-G-2100/5, except that plastic-encapsulated devices may be used.

3.6.5 Service conditions.- Service conditions for the multifunction amplifier assembly shall be in accordance with environment I specified by FAA-G-2100/1. The ac line power shall be derived from a three-wire ac line, single phase, with a design center voltage of 120 volts as required by FAA-G-2100/1.

3.7 Special tools and test equipment.- The contractor shall supply with each equipment any special tools and any special test equipment required to maintain this equipment, including lamp puller, etc., as specified in the contract schedule and as specified in the following subparagraphs. A suitable portion of the equipment instruction book shall be devoted to these equipments. The equipment shall be designed so that it will not interfere with nor be susceptible to any environmental disturbance (3.3.9).

3.8 Prototype equipment.- Prototype equipment shall meet all requirements of this specification.

3.8.1 Tests.- All tests required by section 4 of this specification shall apply to the prototype equipment. The equipment may be delivered on the contract schedule after it has been reworked to new conditions prior to acceptance.

3.9 Instruction books.- Instruction books shall be furnished in accordance with FAA-D-2494/1 and 2494/2 and in quantities specified in the contract schedule.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- The contractor shall provide and maintain a quality control program which fulfills the requirements of FAA-STD-016. The contractor's quality program shall be a scheduled and disciplined plan of events integrating all necessary inspections and tests required to substantiate product quality during design, development, purchasing, subcontracting, manufacture, fabrication, processing, assembly, acceptance, packaging, and shipping. The contractor shall perform or have performed the inspections and tests required to substantiate product configuration and conformance

to drawings and specifications. The contractor shall provide and maintain measuring and testing devices in accordance with FAA-G-2100/1. Classification of tests and general methods of sampling and inspection shall be in accordance with FAA-G-2100/1.

4.1.1 Classification of tests.- Four classes of tests are required as follows:

(a) Contractor's preliminary tests (4.2.1)

(b) Design qualification tests (symbolized by D) (4.2.2)

(c) Type tests (symbolized by T) (4.2.3)

(d) Production tests (symbolized by P) (4.2.4)

4.2 Tests.-

4.2.1 Contractor's preliminary tests.- Contractor's preliminary tests as specified in FAA-G-2100/1 shall be performed. The contractor shall perform a preliminary test at the factory in accordance with government approved test procedures. A full factory aggregation of all equipment provided by the contract, with the exception of the spare parts, shall be integrated at the factory as a complete system. The system shall be subjected to all requirements. The spare parts shall be tested subject to all requirements stated herein.

4.2.2 Design qualification tests.- These tests shall include test items of 4.2.5. All design qualification tests, including the systems tests, shall be performed on the prototype unit and on the entire first lot of units manufactured and delivered. The design qualification tests shall be made while subjecting the equipment to the test procedure prescribed in FAA-G-2100/1. The first amplifier assembly enclosure, complete with plug-in modules, shall receive the tests. Each of the tests shall be conducted at 22.5, 24.0, and 26.0-V dc power inputs. These design qualification tests shall be in accordance with FAA-G-2100/1.

4.2.2.1 Rating tests and general qualification tests.- Rating tests and general qualification tests shall be performed in accordance with FAA-G-2100/1. In addition, the design qualification test shall consist of all those tests necessary to verify compliance to the requirements of this specification.

4.2.2.1.1 Prototype testing.- The prototype shall be subject to an environmental test performed in accordance with FAA-G-2100/1 to demonstrate performance over the stated service conditions.

4.2.2.2 Environmental tests.- The service conditions shall be those specified by FAA-G-2100/1.

4.2.3 Type tests.- Type tests shall be performed under service conditions and in accordance with FAA-G-2100/1. The type tests shall include test items of 4.2.5. Each component or part of the equipment shall be functionally tested at all environmental extremes specified by FAA-G-2100/1. Each test shall be conducted at either 22.5, 24.0, or 26.0 V dc. The voltage selected for each series of tests shall be at the discretion of the FAA representative.

4.2.4 Production tests.- The production tests shall be in accordance with FAA-G-2100/1. The production tests at the factory shall show that each unit of the equipment performs as specified under normal test conditions. The test shall include all items indicated in 4.2.5.

4.2.5 Test designations according to specification paragraphs.- The following is a list by paragraphs of items to be tested by design tests (D), type tests (T), and production tests (P):

Test item	Test designation	Paragraph number
Base amplifier module	DTP	3.3.1
Maximum gain	DTP	3.3.1.2
Rated output	DTP	3.3.1.3
Frequency response	DTP	3.3.1.4
Harmonic distortion	DTP	3.3.1.5
Hum distortion	DT	3.3.1.6
Noise level	DT	3.3.1.7
Cross talk	DT	3.3.1.8
No load operation	DT	3.3.1.9
Gain control	DTP	3.3.1.10
Output transformer	DTP	3.3.1.11
Linear amplifier submodule	DT	3.3.2
Linear amplifier function	DT	3.3.2.1
Input circuits	DT	3.3.2.2
Input transformer	DT	3.3.2.2.1
Input ground	DT	3.3.2.3
Input impedance tolerance	DT	3.3.2.4
Input shielding	DT	3.3.2.5
Regulated output amplifier submodule	DT	3.3.3
Regulated output amplifier function	DT	3.3.3.1
Gain	DT	3.3.3.2
Sensitivity	DT	3.3.3.2.1
Regulator output control range	DT	3.3.3.3
Input attenuator	DT	3.3.3.3.1
Regulator input control range	D	3.3.3.4
Regulating range	DTP	3.3.3.5
Regulator attack time	DTP	3.3.3.6

Test item	Test designation	Paragraph number
Regulator release time	DTP	3.3.3.7
Mixer amplifier submodule	DTP	3.3.4
Mixer amplifier function	DTP	3.3.4.1
Four input circuits	D	3.3.4.2
Attenuator mounting terminals	D	3.3.4.3
Input signal levels	D	3.3.4.4.
Output level adjustment	DT	3.3.4.4.1
Input attenuator pads	DTP	3.3.4.5
Tone supression amplifier submodule	DT	3.3.5
Tone supression amplifier function	DT	3.3.5.1
Regulator output control range	DT	3.3.5.2
Regulator input control range	DT	3.3.5.3
Regulating range	DTP	3.3.5.4
Regulator attack time	DTP	3.3.5.5
Regulator release time	DTP	3.3.5.6
Tone suppression	DTP	3.3.5.7
Noise suppression	DTP	3.3.5.8
Output level	DT	3.3.5.9
Mode switch	D	3.3.5.10
Power supply requirements	DT	3.3.6, 3.3.6.2
Voltage output and ripple	DT	3.3.6.1.1
Regulation	DTP	3.3.6.1.2
Load regulation	DT	3.3.6.1.3, 3.3.6.2.5
Regulation response	DT	3.3.6.1.4
Voltage adjustment	DT	3.3.6.1.5
Overload protection	DTP	3.3.6.1.6, 3.3.6.2.2
Overvoltage protection	DTP	3.3.6.1.7
Module failure	DTP	3.3.6.1.7.1
DC output	DTP	3.3.6.9, 3.3.6.2.4
Ripple	DTP	3.3.6.1.1, 3.3.6.2.6
Failure detector	DTP	3.3.6.1.10, 3.3.6.2.3
AC line controls	D	3.3.6.1.11, 3.3.6.2.7
AC input	D	3.3.6.1.8
Module test adapter	D	3.3.7
Test set	DP	3.3.8
Interference	DT	3.3.9
Construction	D	3.4
Amplifier enclosure	D	3.4.1

Test item	Test designation	Paragraph number
Chassis material and forming	D	3.4.1.1
Cabinet guides	D	3.4.1.2
Weight	D	3.4.1.3
Connectors	D	3.4.1.4
DC power input	D	3.4.1.5
Mating connectors	D	3.4.1.6
Patch and test panel	D	3.4.1.8
Nameplate	D	3.4.1.9
Welding	D	3.4.1.10
Basic module	D	3.4.2
Module panel	D	3.4.2.1
Printed wiring	D	3.4.2.2
Submodules	D	3.4.3
Module test adapter	D	3.4.4
Power supplies	D	3.4.5
Power distribution panel	D	3.4.6
Test set	D	3.4.7
Thermal design test	D	4.3
Integrated circuit quality assurance	D	4.4
Static burn-in test	D	4.4.1
Hermetic seal test	D	4.4.2

4.3 Thermal design test.- The contractor shall perform a thermal design test on one amplifier assembly to verify that the part temperature data used for the reliability prediction (3.5) is accurate. This test shall be conducted in an environment of 40 degrees centigrade and 80 percent relative humidity.

4.4 Integrated circuit quality assurance.- If integrated circuits are used in the equipment specified herein, they shall be subjected to the quality assurance tests in 4.4.1 and 4.4.2. When testing on a lot sample basis is specified, a failure in the sample shall cause either rejection or 100 percent testing of the lot. Failure rate data shall be submitted to the FAA Contracting Officer for use in assessing equipment reliability. If the contractor so desires, he may submit, in lieu of the tests in 4.4.1 and 4.4.2, certified data and a statement from the integrated circuit manufacturer that the integrated circuit meets or exceeds the requirements of the tests.

4.4.1 Static burn-in test.- A 20 to 30 percent lot sample of each linear circuit type to be used in the production equipment shall be given a static burn-in test lasting 48 hours prior to assembly in the equipment. The test shall be conducted at an ambient temperature of 50 degrees centigrade and a relative humidity of 90 percent. For the duration of the static test, each linear circuit shall dissipate the maximum power specified by the integrated circuit manufacturer. Digital circuits to be used in the equipment shall be static tested under the same environment and power conditions; however, testing on a 10 to 15 percent lot sample basis shall be sufficient.

4.4.2 Hermetic seal test.- All flat package integrated circuits shall be subjected to a gross leak and fine leak test after being temperature-cycled from 0 degrees centigrade to 50 degrees centigrade. The leak tests shall be conducted at room temperature. Not less than 15 percent of each manufactured lot of TO-5 packages shall be tested under the same conditions. (TO-5 is a designation for a metal case used for enclosing transistors, integrated circuits, and solid-state circuits.)

5. PREPARATION FOR DELIVERY

5.1 General.- Preparation of equipment for delivery shall be in accordance with MIL-E-17555.

5.2 Shipment of material.- Shipments of material from the contractor's plant to a specific site within the continental limits of the United States for immediate use shall be prepared for delivery using level C.

5.3 Material for inventory storage.- Material delivered for inventory storage shall be handled, preserved, and packed at level A.

5.4 Equipment for storage.- Equipment delivered for storage at the FAA or a government facility shall be handled, preserved, and packed at level A.

5.5 Small component material.- Small components shall be identified by tagging each item and marking the outside of individual containers as required by MIL-E-17555. Small components shall be handled, preserved, and packed at level C.

6. NOTES

This section is not applicable to this specification.

* * * * *

FOR FIGURES 1 TO 3, SEE PAGES 23 TO 25

A TABLE OF CONTENTS IS ATTACHED AS APPENDIX 1.

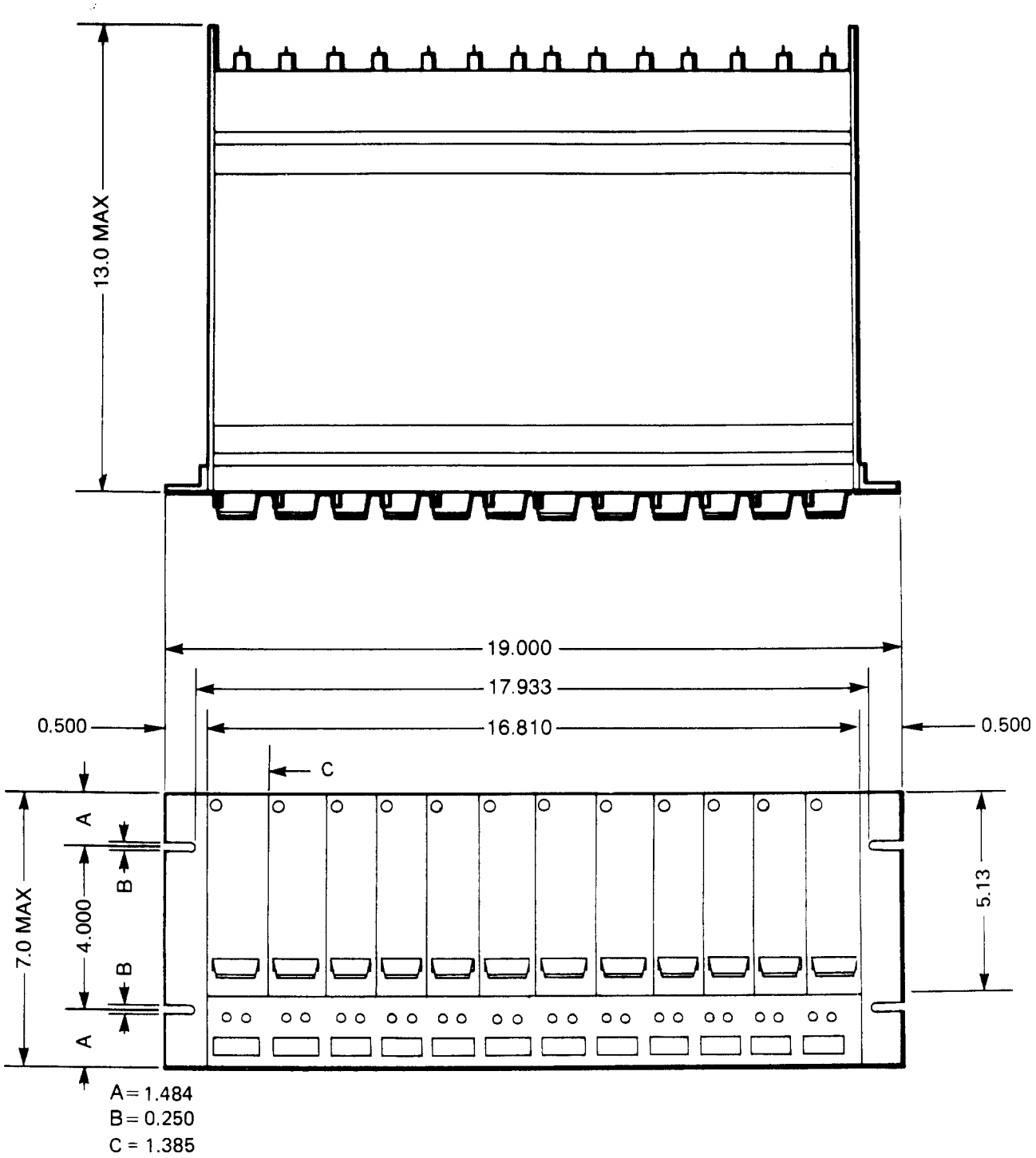

FIGURE 1. MULTIFUNCTION AMPLIFIER ASSEMBLY

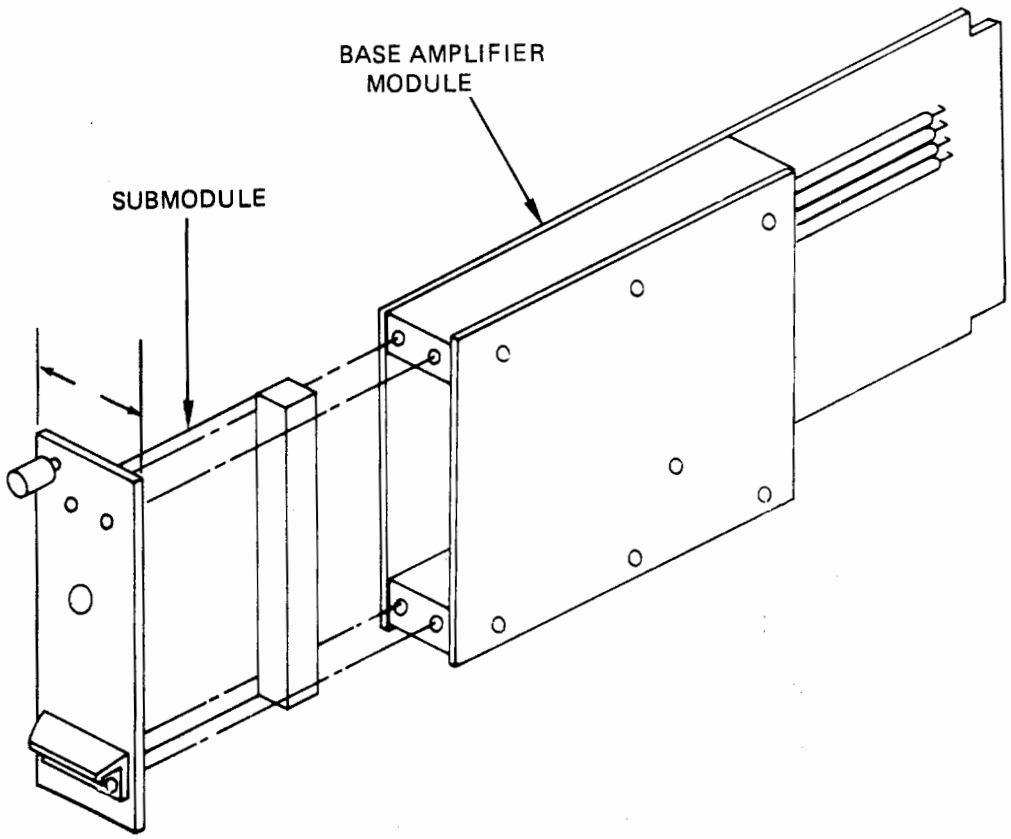

FIGURE 2. AMPLIFIER MODULE

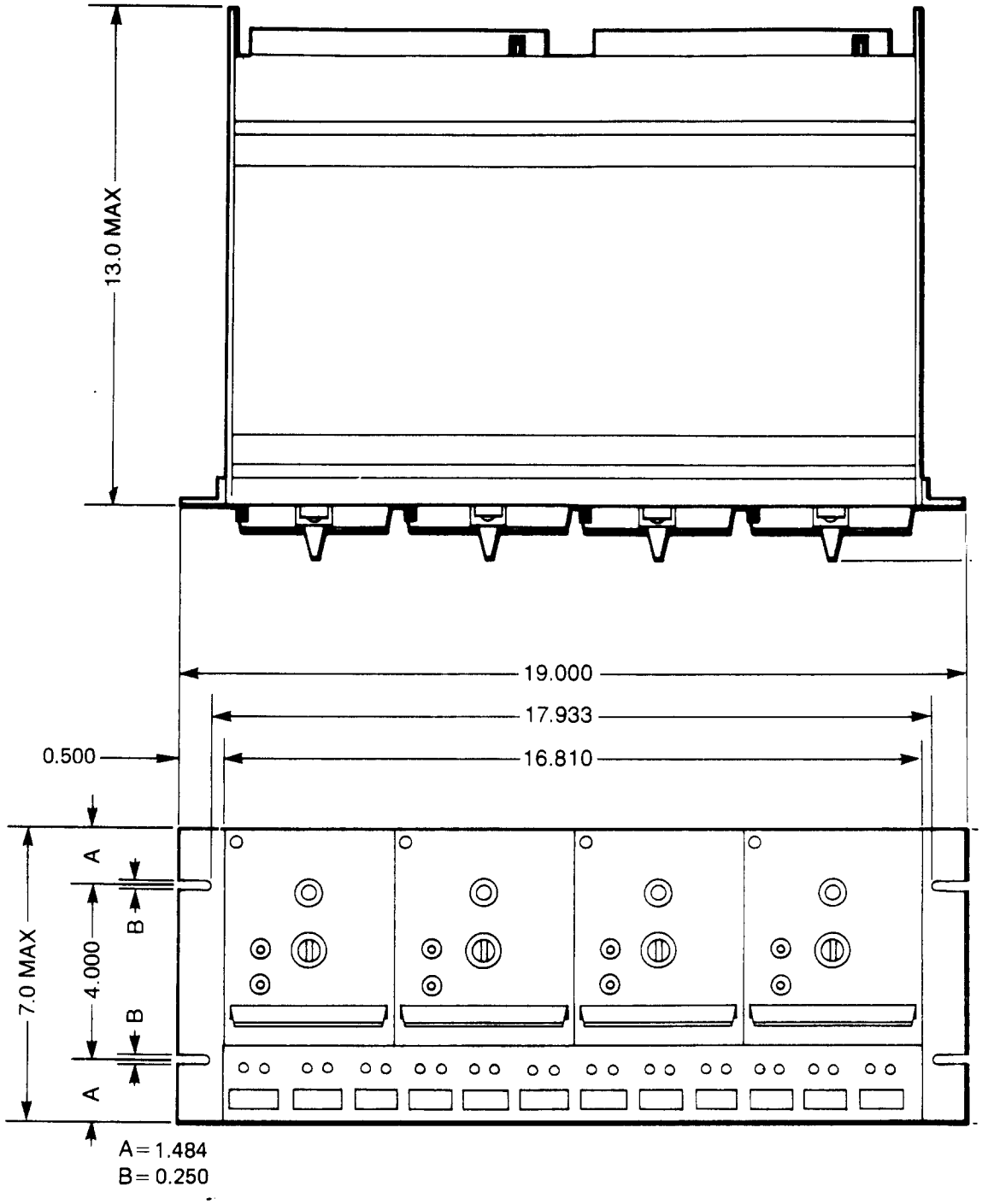

FIGURE 3. MODULAR POWER SUPPLY ASSEMBLY

APPENDIX 1

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